MIL-STD-40051-4

DEPARTMENT OF DEFENSE
STANDARD PRACTICE

TECHNICAL MANUALS

TROUBLESHOOTING PROCEDURES

CONTENTS

MIL-STD-40051-4

CONTENTS

1. **SCOPE.**

1.1   Scope. This standard establishes the technical content requirements for the preparation of troubleshooting procedures for weapon systems and equipment Technical Manuals (TMs) and Depot Maintenance Work Requirements (DMWRs). These requirements are applicable for both paper and digital page-oriented TMs. Electronic delivery of the TMs is accomplished through the use of the Troubleshooting Procedures modular Document Type Definition (DTD). The DTD is available in a digital format. Refer to MIL-STD-40051 for information on obtaining this DTD. All troubleshooting requirements necessary to develop Operator (-10), Unit (-20), Aviation Unit Maintenance (AVUM), Direct Support (DS) (-30), Aviation Intermediate Maintenance (AVIM), General Support (GS) (-40), and/or depot level (overhaul) TMs are included.

2. **APPLICABLE DOCUMENTS.**

The applicable documents in section 2 of MIL-STD-40051 apply to this Part.

3. **DEFINITIONS.**

The definitions in section 3 of MIL-STD-40051 apply to this Part.

4. **GENERAL REQUIREMENTS.**

4.1   General. Troubleshooting procedures shall be prepared for weapon systems, major equipment, components and applicable support and interface equipment. Troubleshooting procedures and supporting illustrations shall be prepared so that operator/crew and maintenance personnel can perform all required operator through depot level (overhaul) troubleshooting. This information shall be contained in work packages and become a part of a Troubleshooting Information Chapter.

4.2   Development of troubleshooting instructions. Troubleshooting instructions shall cover all items comprising the weapon system/equipment, such as assemblies, subassemblies, components, wiring, junction boxes, and accessories. Troubleshooting procedures shall isolate faults to the part(s) authorized by the RPSTL for repair or replacement at the maintenance level addressed. Tasks shall be presented in the order in which they are performed. Approved Logistics Support Analysis (LSA), service experience, performance data on similar equipment, and all other reliability, availability, and maintainability (RAM) data available shall be used in the preparation of specific troubleshooting procedures. Troubleshooting procedures shall begin with testing, observed problems, a fault symptom or malfunction and shall diagnose to a single fault/failure. Troubleshooting shall refer to specific maintenance or repair tasks to correct the fault. Instructions, where applicable, shall flow from operator level through unit/AVUM, direct support/AVIM, and general support until the fault is isolated. Procedures shall include schematics and illustrations as needed (or shall reference to required schematics, etc.). Troubleshooting data shall be test and fault-isolation oriented. Troubleshooting instructions shall include detailed inspection and troubleshooting information. Instructions shall include a reference to functional descriptions of subsystems being diagnosed to aid the operator/technician. The method used for identifying system equipment test points, including the requirements and methods of determining defects through visual inspection, shall be explained.

4.3   Maintenance level applicability. Requirements contained in this standard are applicable to all maintenance levels unless specifically noted in bold and in parentheses (i.e., **-34 only**). The labeled requirements shall be applicable to all TMs containing that maintenance level. For example, a **(-20 only)** requirements would only be applicable to the following TMs: -12, -13, -14, -20, -23, and -24.

4.4   Depot maintenance work requirements. When the contracting activity specifies that a Depot Maintenance Work Requirement (DMWR) shall be prepared to the best commercial practices, the depot requirements contained in this standard shall be used only as a guide; therefore, the conforming modular DTD for troubleshooting procedures cannot be used.

4.5   Standard tables. Various standard tables required are noted throughout the text of this standard in bold and in parentheses (i.e., **(standard table)**). The formats and table heading names of these standard tables shall have no deviations.

4.6   Preparation of digital data for electronic delivery. Technical manual data prepared in work package format and delivered digitally in accordance with this standard shall be SGML tagged and assembled using the modular Assembly DTD and Formatting Output Specification Instance (FOSI). The DTD and FOSI have been developed in accordance with MIL-PRF-28001 and ISO 8879. Refer to MIL-STD-40051 for information on obtaining or accessing the modular DTD and FOSI. SGML tags used in the modular DTD are noted throughout the text of this standard in bracketed, bold characters (i.e., <**tswp**>) as a convenience for the TM author and to ensure that the tags are used correctly when developing a document instance.

4.6.1 Use of DTDs / FOSIs. The modular DTDs referenced in this standard interpret the technical content and structure for the functional requirements contained in this standard and are mandatory for use. The modular FOSIs referenced herein interpret the style and format. As specified by the contracting activity, FOSIs or style sheets may be used to produce final reproducible paper copy for all TMs prepared in accordance with this standard.

4.7   Content structure and format. The examples provided at the rear of this Part are an accurate representation of the content structure and format requirements contained herein and shall be followed to permit the effective use of the modular DTD for Troubleshooting Procedures.

4.8   Style and format. Style and format requirements for the preparation of Department of Army TMs are contained in MIL-STD-40051-1 and are considered mandatory and are intended for compliance. Preferred general style and format requirements for Army TMs shall be provided by the procuring activity.

4.9   Work package development. Technical manual data developed in accordance with this standard shall be divided into individual, stand alone units of information work packages. A work package shall consist of descriptive, operational, maintenance, troubleshooting, support, or parts information for the weapon system or equipment.

4.10 Safety devices and interlocks. Information shall be prepared pertaining to the purpose and location of all safety devices and interlocks in conjunction with the pertinent procedures.

4.11 Electrostatic discharge (ESD) sensitive parts. If the equipment contains ESD sensitive parts, components, or circuits, cautions and ESD labels shall be incorporated into the applicable tasks and procedures to ensure ESD sensitive parts are not damage or degraded during handling or troubleshooting. Refer to MIL-STD-40051-1 for requirements on labeling ESD. Actions which could damage ESD sensitive parts, but which are not directly related to handling or troubleshooting of ESD sensitive parts, shall not be annotated with the ESD acronym, but shall be preceded by a caution statement.

4.12 Nuclear hardness. If the weapon system/equipment has nuclear survivability requirements (for example, over pressure and burst, thermal radiation, electromagnetic pulse, or transient radiation effects on electronics), cautions and Hardness-Critical Processes (HCP) labels shall be incorporated into the applicable

tasks and procedures to ensure the hardness of the equipment is not degraded during handling or troubleshooting. Refer to MIL-STD-40051-1 for requirements on labeling with HCP. Actions which could degrade hardness, but which are not directly involved in establishing nuclear hardness, shall not be annotated with the acronym, but shall be preceded by a caution statement.

4.13 <u>Selective application and tailoring</u>. MIL-STD-40051 contains some requirements that may not be applicable to the preparation of all technical manuals. Selective application and tailoring of requirements contained in MIL-STD-40051 are the responsibility of the contracting activity and shall be accomplished through the use of Appendix A, Technical Manual Content Selection Matrixes, of MIL-STD-40051. The applicability of some requirements is also designated by one of the following statements: unless specified otherwise by the contracting activity; as/when specified by the contracting activity; or when specified by the procuring activity.

5. **DETAILED REQUIREMENTS.**

5.1 <u>Preparation of troubleshooting procedures</u>. Troubleshooting procedures shall be prepared as a Troubleshooting Information Chapter **<tim>**. This chapter shall be subdivided into individual work packages that provide all troubleshooting information to enable a technician to locate a malfunction in the weapon system/equipment to the assembly, subassembly, component or piece part. Troubleshooting tasks and depth of coverage shall be developed in accordance with the Logistics Support Analysis (LSA)/Maintenance Allocation Chart (MAC) or Maintenance Plan and the Source, Maintenance, and Recoverability (SMR) codes developed for the weapon system/equipment. Other factors to be considered in the development of troubleshooting procedures include, but are not limited to, the following.

    a. Technical experience (target audience).

    b. User environment.

    c. System quick-turnaround requirements.

    d. Test equipment requirements and availability.

    e. Automated versus manual testing.

    f. Replaceable component and part reliability.

    g. Ease of testing.

    h. Test access time.

    i. Test time.

5.2 <u>Troubleshooting procedures content</u>. The procedures shall contain all essential and pertinent information that would be included in any other form of maintenance procedure. This includes warnings, cautions, notes, power turn-on procedures, precheckout procedures, reference diagrams, and initial switch settings. In addition to external causes for malfunctions, troubleshooting should also identify symptoms resulting from failure of every spare and repair part authorized for replacement at user level. Troubleshooting procedures shall be prepared assuming one malfunction at a time is being corrected. The operator/technician shall be instructed to perform any applicable self-tests, alignments, and inspections before beginning any other troubleshooting procedures. As applicable, an operational check shall be specified to be performed

after the fault is corrected to ensure correct operation of the system. Troubleshooting procedural instructions shall be prepared following these general requirements.

a. Assure that procedures are prepared for the operator/technician at an appropriate level of knowledge of the systems operation and that systems relationship to peripheral assemblies is explained.

b. When all probable faults have been determined and described, prepare a malfunction/symptom index work package using the exact description of the fault or symptom as was used in the troubleshooting procedures. Group symptoms to common system areas both in the malfunction/symptom index and in the troubleshooting procedures. For example, if a system has a data link, communications, radar, display, and tracking systems, the symptoms would be grouped into each related area. All fault symptoms of a communications nature would fall into the communications group. The symptoms may be further divided into functions within the communications group that would be common. The same would be done for radar, data link, display, and tracking systems.

c. Develop the troubleshooting procedures based on tests, measurements, and decisions that must be made in order to reach the final outcome of isolating the fault to a replaceable component related to the symptom. All of the most probable faults and causes shall be considered. The troubleshooting procedures shall provide the operator/technician with the means of isolating system failures to the faulty line replaceable item/shop replaceable unit

d. List any self-tests that are associated with the system. Self- test schemes shall be described as the prime troubleshooting tool, with manual troubleshooting prepared to supplement the instructions where the self-test leaves off or fails to locate the malfunction. Build the procedure using system self-tests before using external test equipment. Include any information that will aid the operator/technician, such as waveforms; resistance data; fluid pressures; voltage levels; references to test diagrams, functional diagrams, text, etc.; and alignment procedures, checkout procedures, or other scheduled maintenance procedures. Connector numbers, pin designations, etc., shall be identified.

e. When applicable, the troubleshooting procedures shall take into account the means of fault discovery, such as during operation; during routine maintenance procedures; using nonautomated, semiautomated, or automated test equipment; or using Built-In Test Equipment (BITE).

f. Ensure that the troubleshooting procedures contain all the required references to other troubleshooting aids.

5.3 <u>Testing and troubleshooting</u>. The environment in which testing and troubleshooting procedures will be performed and the volume (bulk) of information required shall be considered. Testing and troubleshooting for a given system shall be presented within a system troubleshooting procedures work package or in a separate assembly troubleshooting procedures work package.

5.3.1 <u>Testing and troubleshooting procedures using test equipment</u>. As applicable, instructions for the use of nonautomated, semiautomated, automated, or BITE in testing and troubleshooting procedures shall be prepared. Procedures for the use of any of this equipment shall be established on the basis of a system test concept. Specific instructions for using any test equipment shall be included in the troubleshooting procedures. Procedures shall cover automated or semiautomated testing performed either to begin a troubleshooting process or to complete a fault isolation step. Malfunction symptoms shall identify specific ports of entry into the testing and troubleshooting cycle. Instructions for repeating time-consuming end-to-end tests shall be avoided. The following procedural content concerning the use of test equipment shall be considered.

a. An identification of the system under test.

b. A concise explanation of the testing and troubleshooting format.

c. Descriptive text identifying components to be installed and an identification of the access to each. The text shall be accompanied by illustrations that show location for each component, accessory, connector, or junction box in the system under test. The text shall also identify every test connector or other test point to be used in the test.

d. A complete list of test options shall be stipulated by the troubleshooting procedure.

e. Test setup procedures and post-test teardown procedures.

f. Complete step-by-step test and troubleshooting procedures, including instructions required for use and application of installed on-line testing equipment. Procedures shall take into account controls, test point accessibility, indicators, displays, and the feasibility of using BITE or automated test equipment where available.

g. Test procedures (e.g., system turn on, identification of time required to run and complete the system test, and an indication of any possible mid-test interruptions or stoppages and how to respond to them).

h. Backup diagrams showing all test points, input and output signals, logic charts, schematics, signal flow diagrams, tables, and other illustrations as required for comprehensible understanding of the procedures.

5.4 <u>Troubleshooting Information Chapters **\<tim\>**</u>. Troubleshooting Information Chapters **\<tim\>** shall be developed for the weapon system/equipment. Chapters shall consist of a title page (refer to MIL-STD-40051-1) and the troubleshooting work packages described in paragraph 5.5. Each Chapter shall be titled "Troubleshooting Procedures" followed by end item/system, subsystem, component, assembly, subassembly name, as applicable (e.g., Troubleshooting Procedures for the M101 Howitzer). When the TM contains more than one level of maintenance, the title of each chapter shall also be preceded by the maintenance level (e.g., Unit Troubleshooting Procedures for the Landing Control Central AN/TSQ-71B).

5.5 <u>Types of troubleshooting work packages</u>. Chapters shall include the following work packages, as applicable: introduction, malfunction/symptom index and troubleshooting procedures.

5.5.1 <u>Introduction work package **\<tsintrowp\>**</u>. This work package shall consist of descriptive data which explains how to use **\<howtouse\>** the malfunction/symptom index and troubleshooting procedures work packages. Examples shall be included with the descriptions. This work package may contain any other general information needed to supplement the troubleshooting procedures. (Refer to figure 1.) The following qualifying statements shall be included, as applicable, in the Introduction work package.

a. This table lists all the common malfunctions that you may find with your equipment. Perform the tests, inspections, and corrective actions in the order they appear in the table.

b. This table cannot list all the malfunctions that may occur, all the tests and inspections needed to find the fault, or all the corrective actions needed to correct the fault. If the equipment malfunction is not listed or actions listed do not correct the fault, notify your supervisor.

5.5.2   Troubleshooting reference index work package **<tsindxwp>**. This work package shall consist of either a system/subsystem index **<tsindx>** or a malfunction/symptom index **<tsindx>**. When applicable, one troubleshooting reference index work package shall be prepared for all troubleshooting chapters. As required, additional malfunction/symptom index work packages may be included. (Refer to figure 2.)

5.5.2.1 Malfunction/symptom index **<tsindx>**. This index shall include the following data.

    a. List all fault symptoms or known malfunctions in alphabetical order by malfunction/symptom or by built in test code.

    b. For complex systems, list symptoms by subsystem categories, if necessary, and use codes that help identify specific items. (Subsystem categories shall be listed in alphabetical order or by code.)

    c. Catalog malfunctions/symptoms by method of detection, if this aids usability.

    d. Reference the appropriate troubleshooting procedures work package. Fault symptom descriptions shall be standardized between malfunction/symptom index work packages **<tsindxwp>** and troubleshooting procedures work packages **<tswp>**.

5.5.2.2 System/subsystem index **<tsindx>**. This index shall consist of a list of work packages relating to specific systems, subsystems, assemblies and components.

5.5.3   Troubleshooting testing work package **<testmodulewp>**. As applicable, when troubleshooting procedures reference automated or semiautomated test equipment that is necessary to be used either to begin the troubleshooting process or to complete a fault isolation step, a troubleshooting testing work package may be prepared. The troubleshooting testing work package shall consist of a scope of task, an initial setup, and the test procedures. A troubleshooting testing work package may include test set hookup and disconnect procedures, index of test set message words, a reference index of test set or BIT/BITE fault codes and related actions, and further testing procedures related to the message words and fault codes. When applicable, the information contained in this work package may be included in the troubleshooting procedures work package. (Refer to 5.5.4).

5.5.4   Troubleshooting procedures work packages **<tswp>**. The troubleshooting procedures work packages shall consist of: scope of task (THIS WORK PACKAGE COVERS:), initial setup, and troubleshooting procedures. (Refer to figure 3.)   Work packages will relate either to a specific symptom or to a system, assembly, or component. Work packages related to a system of some complexity may contain more than one set of troubleshooting procedures directed to specific subsystems. Work packages may contain supporting technical data as detailed in paragraph 5.3.1h.

5.5.4.1 Scope of task **<wpsum>**. The scope of task (THIS WORK PACKAGE COVERS:) shall be required for all troubleshooting procedures work packages. The scope of task shall list all the tasks that must be performed to complete the procedures. The scope of task allows a technician to select everything needed at the start of the job without checking through the task list. Presentation shall be consistent throughout all work packages. (Refer to figure 3.)

5.5.4.2 Initial setup information **<wpinfo>**. Initial setup information shall be included in each work package and shall immediately follow the scope of task. (Refer to figure 3.) It provides the operator/maintenance technician with general information, equipment, parts, material, and authorized personnel required to perform and complete all the troubleshooting tasks included in the work package. Setup information requirements are described below:

a. Maintenance level **<maintlvl>**. The level of maintenance authorized to perform the maintenance contained in the work package (in accordance with the approved MAC) shall be stated. This shall be included for operator or crew, unit, AVUM, direct support, general support, AVIM, and depot levels of maintenance, as applicable. For example,

Maintenance Level
  Unit

b. Applicable configurations **<appconfig>**. When the work package does not apply to all configurations of the weapon system/equipment, the applicable configurations **<name>** covered by the work package shall be listed. Omit this requirement if the same tasks/procedures apply to all configurations. (If certain configurations require different tasks/procedures, separate work packages shall be prepared.) For example,

Applicable Configurations
  Serial Numbers 12345 through 12399

c. Test equipment **<testeqp>**. All test equipment required to perform the procedure shall be listed by name **<name>** and part **<partno>** or model number **<modelno>** designation if this information is not contained in an overall list elsewhere in the TM. If such a list exists, refer to it by name **<name>**, item number, and work package number **<simref>** instead of repeating the information throughout the TM. For example,

Test Equipment
  Multimeter (Item 4, WP 0108 00)
  Oscilloscope (13057)

d. Tools and special tools **<tools>**. The tool kit (box) assigned to the mechanic (on a 1-per-mechanic-by-MOS basis) to be used in maintenance of a particular equipment shall be listed by name **<name>**, tool kit number (**<partno>** or **<nsn>**), supply catalog (SC) **<sc>**, or TM number **<tmno>** if this information is not included in the Tool Identification List work package contained in the TM. If such a list exists, refer to it by name **<name>,** item number and work package number **<simref>** instead of repeating the information throughout the TM. No tool in the kit shall be further identified. Other tools required for performance of all tasks for the maintenance levels covered in the work package shall also be identified in the initial setup and shall be referenced to the Tool Identification List work package. "Other tools" includes tools which are part of/components of shop sets authorized to sections/teams; tools authorized by RPSTL and CTA-50-970; special and fabricated tools; and items of TMDE. For example,

Tools and Special Tools
  Fixed Open End Wrench Set (Item 47, WP 0110 00)
  Screw Threading Set (SC number)
  Vehicle Tool Kit (407425)

e. Materials/parts **<mtrlpart>**. All expendable items and support materials shall be listed **<name>**. The item number and supporting information work package **<simref>** which lists these items shall be given. Mandatory replacement parts shall be listed by name **<name>** (and part number **<partno>**, if any). The number, quantity **<qty>**, or size necessary to complete the task shall be

listed, when applicable. When a mandatory replacement parts work package exists, it shall be referred to in lieu of the part number. For example,

Materials/Parts
Grease (Item 5, WP 0112 00)
Wiping Rags (Item 38, WP 0112 00)
Range Lock (P/N 8675309)
Range Lock Flange Kit (P/N 8675310)

f. Personnel required **\<persnreq\>**. Personnel **\<name\>** and the number of personnel **\<qty\>** shall be identified if the task requires more than one. The Military Occupational Specialty (MOS) designation **\<nameid\>** is not necessary, but it may be included. For example,

Personnel Required
Artillery Mechanic 68M10 (1)
Artillery Mechanic 66J30 (1)

g. References **\<ref\>**. TMs, other work packages, and other sources (**\<extref\>/\<xref\>**) that are needed to complete the maintenance tasks shall be listed here. Only references not listed in equipment conditions shall be listed. For example,

References
TM 9-1015-252-20&P
WP 0100 00

h. Equipment conditions **\<eqpconds\>**. Any special equipment conditions required before the procedure can be started shall be listed here and cross-referenced to the appropriate source (**\<extref\>** or **\<xref\>**) for setting up the condition **\<condition\>**. For example,

Equipment Condition
Firing mechanism removed (WP 0100 00)

i Special environmental conditions **\<specenv\>**. Any special environmental conditions (such as ventilation, lighting, or temperature) **\<condition\>** that are required shall be listed here. The reason **\<reason\>** that such conditions are needed shall be explained. For example,

Special Environmental Condition
Darkened area required for testing lights.

j. Drawings required **\<dwgreq\>**. All drawings (which are not included in the work package) required to complete the maintenance tasks shall be listed here. Drawings shall be listed by title **\<dwgname\>** and drawing number **\<dwgno\>**. For example,

Drawings Required
Power Supply Schematic (132E470092)

5.5.4.3 End of task identifier. The words **END OF TASK** shall be placed below the last item (i.e., text, illustration, etc.) in any work package containing procedures.

5.5.4.4 Troubleshooting procedures. The selection of a troubleshooting type shall be based on the type of equipment or assembly/subassembly being addressed, the target audience description, and the maintenance

level of the operator/technician. Once selected, the troubleshooting type shall be prepared in accordance with the requirements specified by this document. Troubleshooting procedures work packages shall be prepared in one of the following types:

5.5.4.4.1   Tabular. Tabular troubleshooting procedures shall be prepared in one of two standard tables.

    a. When the troubleshooting procedure is based on a test procedure **<opertest>**, a standard troubleshooting table in the format of figure 4 **(standard table)** shall be prepared. The first column of this table shall have an item number and a procedure **<test>** that leads to an indication **<indication>**. The second column shall list the normal indication. The third column of the table shall list the corrective actions **<action>** to follow or reference appropriate maintenance work packages or the applicable TM.

    b. When the troubleshooting procedure is based on a known malfunction **<known-malfunc>** that will be diagnosed and corrected through a testing procedure, a standard troubleshooting table **<faulttest>** in the format of figure 4 **(standard table)** shall be prepared. This table shall list item numbers and the malfunctions **<malfunc>** in the first column. The second column shall list the test or inspections **<testing>** (what to check for concerning the malfunction listed). The last column shall give the corrective action **<action>** in detail or shall reference the corrective action.

    c. When a known malfunction **<known-malfunc>** exists, a standard troubleshooting table **<faultpath>** may be prepared listing the probable causes **<suspect-fault>** of each malfunction **<malfunc>** with a related corrective action for each cause. The methodology is to diagnose a malfunction's cause by determining what corrective action clears up the malfunction. The first column shall list the item number and malfunction **<malfunc>**. The second column shall list each probable cause **<suspect-fault>** with its corrective action **<action>** or a reference to the action aligned in the third column. (Refer to figure 4.)

5.5.4.4.2   Functional flow tree **<functnl-flow>**. This fault isolation technique shall be composed of a series of operation and decision routines. These troubleshooting procedures shall be presented graphically in functional order and may be supported by functional diagrams. (Refer to figure 5.) Each troubleshooting routine shall be prepared using a standardized set of graphic symbols. The purpose, meaning, and use of the symbols are as follows. Preparation of a functional-flow work package shall be based upon a systematic tracking of faults being tested; each test unit will either isolate or clear the fault(s).

NOTE

If logic tree was prepared as a graphic, treat logic tree as graphic in the SGML document instance.

    a. An oval shall be used to provide directive information.

    b. A square shall be used to provide instructions for a step to be performed. The instruction shall be prepared in an abbreviated format. For example, CODING SWITCH OFF, shall be used in lieu of "Set the coding switch to the CODING OFF position."

    c. A diamond shall be used to propose a question to be answered with "yes" or "no." Arrows shall direct the operator/technician to further instructions depending upon whether a "yes" or "no" was the answer to the previous question.

d. If the logic tree continues to another page or figure, sufficient information shall be placed on the page or figure of origin to indicate the location of the continuation of the diagram. For example, on the left side of the page, a symbol and explanation shall be placed explaining the origin. On the right side of the page, a symbol and explanation shall be placed explaining the destination. (Refer to figure 5.)

5.5.4.4.3   Narrative. Narrative troubleshooting procedures may be prepared in one of the following formats.

a. The first method **<passfailck>** shall include an item number followed by item or signal names, locations, codes, appropriate data, expected conditions, displays, responses, remarks, and pass/fail instructions, as applicable. Each topic shall be followed by its description, further information, or instructions, etc. (Refer to figure 6.)

b. The second method shall list the malfunction or fault symptom as the work package or task title. The text shall include an item number followed by instructions, checks, tests, and inspections **<test>**, as applicable. Each procedure shall be followed by a question **<query>** concerning the results of the procedure just performed. The operator/technician shall then be given "yes" or "no" **<answer>** answers with corrective actions to follow for the applicable answer. (Refer to figure 7.)

5.5.5   Illustrations. Work packages in the troubleshooting information chapter shall be supported by illustrations to ensure all information needed to perform troubleshooting is complete and comprehensible. In addition to the figures previously referenced, refer to figures 8 and 9 for examples of troubleshooting test setup and test cable interconnection diagrams.

6.   **NOTES**.

The notes in section 6 of MIL-STD-40051 apply to this Part.

TM 3-6665-339-10

INTRODUCTION	0401 00

MALFUNCTION/SYMPTOM INDEX

The malfunction/symptom index (WP 0402 00) is a quick reference index for finding troubleshooting procedures. Associated with each symptom name is a work package sequence number representing the starting point in a troubleshooting sequence. Should any one symptom require more than one troubleshooting sequence to arrive at the most likely area of investigation, the additional starting point numbers are presented.

As the troubleshooting activity progresses through to the conclusion of a particular sequence, a reference is made to the next logical troubleshooting sequence by work package sequence number or by referring to the malfunction/ symptom index to locate the next failure symptom work package. This type of activity continues until successful fault isolation is achieved.

TROUBLESHOOTING PROCEDURES

The troubleshooting work packages contain tables listing the malfunctions, tests or inspections, and corrective action required to return the vehicle to normal operation. Perform the steps in the order they appear in the tables.

Each work package is headed by an initial setup. This setup outlines what is needed as well as certain conditions which must be met before starting the task. DON'T START A TASK UNTIL:

You understand the task.

You understand what you are to do.

You understand what is needed to do the work.

You have the things you need.

This manual cannot list all malfunctions that may occur, or all tests or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify unit maintenance.

GENERAL INFORMATION

If any circuit breaker pops out after it has been pushed in, notify unit maintenance.

When instructions to lubricate, grease, or oil appear in the troubleshooting work package, refer to LO 9-6665-376-12.

0401 00-1

FIGURE 1. Example of an introduction work package.

TM 3-6665-339-10

MALFUNCTION/SYMPTOM INDEX   **1102 00**

Malfunction/Symptom	**Troubleshooting Procedure**
LEFT DATA WORD DISPLAY WARNINGS	
1. BRAKE comes on	WP 1203 00
2. AIR PRESSURE does not come on - brake pressure is low	WP 1203 00
3. COOLANT comes on and ENG. COOLING gage indicates excessive coolant temperature	WP 1203 00
4. ENG. OIL PRESS comes on and engine oil pressure is low	WP 1203 00
5. HYDRAULIC OIL comes on	WP 1203 00
6. HYDRAULIC OIL does not come on - reservoir level is low	WP 1203 00
DRIVER'S LEFT INSTRUMENT PANEL INDICATOR LIGHTS	
1. STANDBY HYDRAULIC indicator light does not come on with emergency hydraulic system on	WP 1304 00
2. TRUCK TURN SIGN light does not come on when push lever on steering column switch is pulled upward or pushed downward - vehicle flasher lights operate normally	WP 1304 00
3. UPPER BEAM indicator light does not come on - high beam headlights operate normally	WP 1304 00
RIGHT DATA WORD DISPLAY WARNINGS	
1. BATT. CHARGER does not come on when MAIN SWITCH is set to position 1 WP 1405 00	
2. Flasher warning lights do not work	WP 1405 00
3. FUEL does not come on and fuel gage does not indicate low fuel level - fuel level is low	WP 1405 00
4. HYDR PRESS comes on	WP 1405 00
5. BRAKE LINING does not come on - brake lines are leaking WP 1405 00	
COMMANDER'S CONTROLS	
1. NORMAL MODE or SIL WATCH does not appear on commander's data word display when NBC CP SYS. switch is set to either NORMAL MODE or SIL WATCH	WP 1506 00
2. PRESSURE GAGE does not read properly when NBC collective protection system is in NORMAL MODE or SIL WATCH	WP 1506 00
3. DUST FILTER appears on commander's data word display when NBC CP SYS. switch is set to either NORMAL MODE or SIL WATCH	WP 1506 00

1102 00-1

FIGURE 2. <u>Example of a troubleshooting reference index work package</u>.

TROUBLESHOOTING PROCEDURES FOR NBCRS FOX M93A1 **1837 00**

THIS WORK PACKAGE COVERS:
Left Data Word Display Warnings

INITIAL SETUP:

Maintenance Level **Materials/Parts**
Operator Oil (Item 20, WP 0270 00)

LEFT DATA WORD DISPLAY WARNINGS

Table 1. Troubleshooting Procedures.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
1. BRAKE IN LEFT DATA WORD DISPLAY COMES ON	1. Shut down engine (see WP 0087 00).	
	2. Check oil level in brake system master cylinder reservoir (see LO 9-6665-376-12).	1. If brake system master cylinder reservoir level is low, add oil (see LO 9-6665-376-12) and continue normal operation. 2. If brake system master cylinder level is above minimum level mark, go to step 3.
	3. Check oil level in hydraulic brake system expansion tank (see LO 9-6665-376-12).	1. If oil level in hydraulic brake expansion tank is low, add oil (see LO 9-6665-376-12) and continue normal operation. 2. If oil level in hydraulic brake expansion tank is above minimum level mark, notify unit maintenance.
2. AIR PRESSURE IN LEFT DATA WORD DISPLAY DOES NOT COME ON - BRAKE PRESSURE IS LOW	1. Shut down engine (see WP 0087 00)	

1837 00-1

FIGURE 3. <u>Example of a troubleshooting work package, scope of task, initial setup and troubleshooting procedure.</u>

ITEM/PROCEDURE	NORMAL INDICATION	CORRECTIVE ACTION
3. On URO, press RCVD key.	URO displays the following: MODE ⌐MSG¬ MESSAGE DESCRIPTOR \[R\] |\[E\]\[C\]| \[T\]\[E\]\[S\]\[T\]\[O\]\[X\] DUAL | ZONE EAST/BRG NORTH BRG \[A\] |\[S\]\[V\] \[a\]\[a\]\[a\]\[a\]\[x\]\[x\]\[O\]\[X\] SV displayed in ZONE field	1. If URO MESSAGE DESCRIPTOR displays any of the following, replace BUU: FA FAULT BAR FAIL CSC LIM. 2. If URO MESSAGE DESCRIPTOR displays SDU ALRM, perform the

TABULAR TROUBLESHOOTING PROCEDURE BASED ON TEST PROCEDURES

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
16. WATER PUMP FAILS TO ROTATE	1. Check for broken or cracked motor, damaged shaft threads, and bent shaft.	1. Replace motor if defective (WP 1520 00 or WP 1521 00). Remove the motor, using illustrated instructions below. 2. Tag and disconnect electrical leads as necessary.

TABULAR TROUBLESHOOTING PROCEDURE BASED ON KNOWN MALFUNCTIONS

MALFUNCTION	PROBABLE CAUSE	CORRECTIVE ACTION
1. With generator power applied to the Shelter, MAIN POWER circuit breaker is off, Phase Sequence light is out.	1. Generator Power 2. Phase Sequence indicator 3. Secondary Filter (FL2) 4. Surge Protector 5. Power Input Filter (FL1) 6. Power Input Cable	1. Check generator output power. Adjust as required. 2. Check connections at generator and shelter. **WARNING** Use extreme caution when making power on checks 3. Check secondary filter (FL2) voltage: 　a. Loosen screws and open cover of FL2 **Note** Use extreme caution when making power on checks Measure LOAD voltage for FL2 terminals

TABULAR TROUBLESHOOTING PROCEDURE BASED ON KNOWN
MALFUNCTION THAT EXISTS

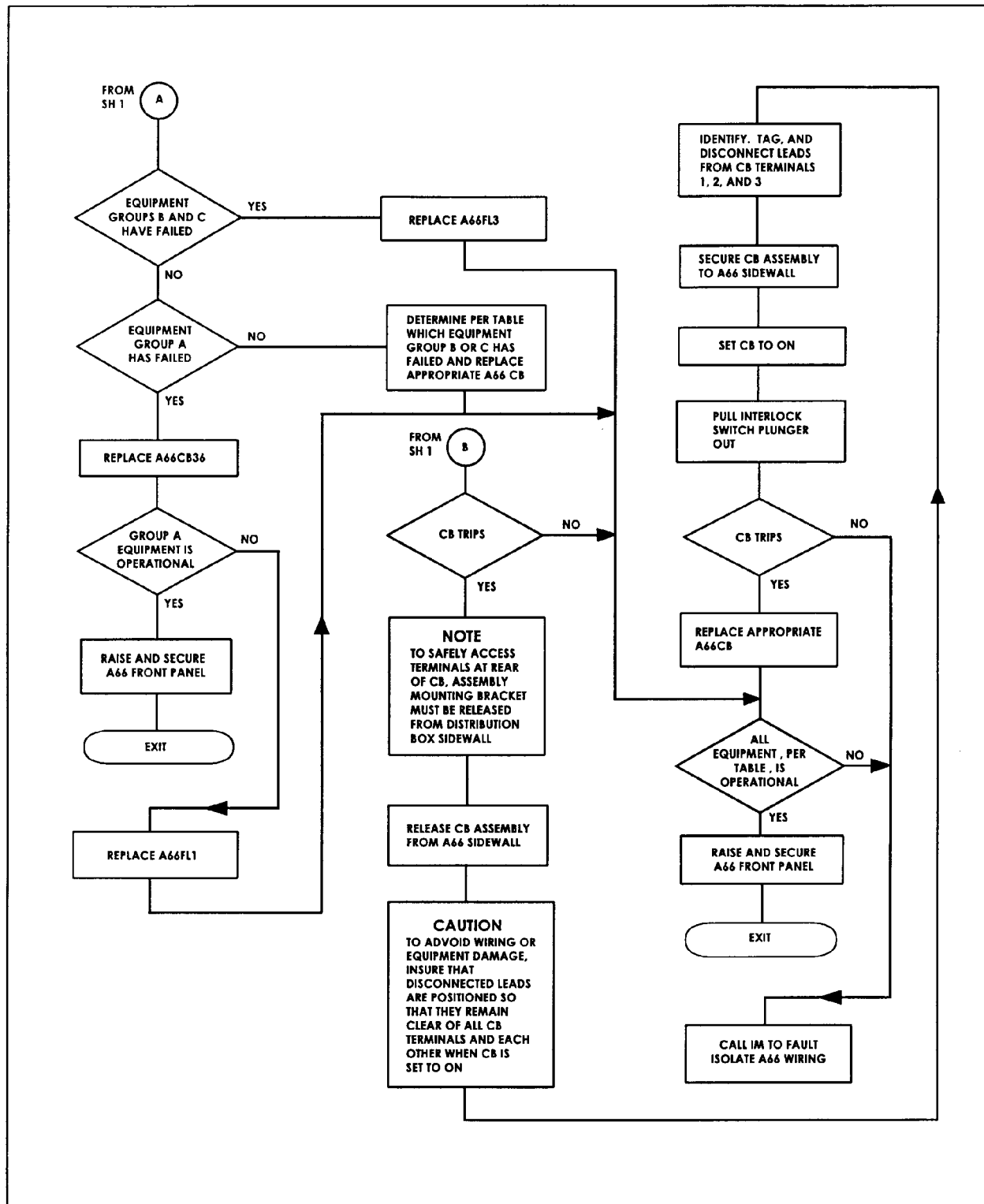FIGURE 4. Example of a tabular troubleshooting procedure.

FIGURE 5. Example of a functional flow logic tree troubleshooting procedure.

AIR DATA SYSTEM TROUBLESHOOTING PROCEDURES - Continued   **0323 00**

RANGE DATA CANNOT BE DISPLAYED - Continued

23. **SIGNAL NAME:** DASEC STATUS WORD DC ANALOG OUTPUT BIT
    MEMORY LOCATION: 002150
    MEMORY DATA BIT(S): 15 (BINARY)
    CONDITION: (None)
    SIGNAL FUNCTION: Indicates status of DC analog circuits.
    REMARKS: From DASEC to FCC.
    PASS: If second digit displayed on HOD is 3 or 7, go to step 24.
    FAIL: Location of fault: replace DASEC (TM 1-1520-238-23 Series).

24. **SIGNAL NAME:** DASEC STATUS WORD AD/DA BIT
    MEMORY LOCATION: 002150
    MEMORY DATA BIT(S): 13 (BINARY)
    CONDITION: (None)
    SIGNAL FUNCTION: Indicates status of analog-to-digital and digital-to-analog circuits.
    REMARKS: From DASEC to FCC.
    PASS: If third digit displayed on HOD is 1, 3, 5, or 7, go to step 25.
    FAIL: Location of fault: replace DASEC (TM 1-1520-238-23 Series).

25. **SIGNAL NAME:** DASEC STATUS WORD FD/LS TEST
    MEMORY LOCATION: 002150
    MEMORY DATA BIT(S): 12 (BINARY)
    CONDITION: (None)
    SIGNAL FUNCTION: Indicates FD/LS ground test is being run.
    REMARKS: From DASEC to FCC.
    PASS: If third digit displayed on HOD is 1 or 5, go to step 26.
    FAIL: Location of fault: replace DASEC (TM 1-1520-238-23 Series).

26. **SIGNAL NAME:** DASEC STATUS WORD ASE BIT
    MEMORY LOCATION: 002150
    MEMORY DATA BIT(S): 11 (BINARY)
    CONDITION: (None)
    SIGNAL FUNCTION: Indicates last FD/LS test ASE bit status.
    REMARKS: From DASEC to FCC.
    PASS: If third digit displayed on HOD is 1, go to step 27.
    FAIL: Location of fault: replace DASEC (TM 1-1520-238-23 Series).

END OF TASK

0323 00-3

FIGURE 6. Example 1 of a narrative troubleshooting procedure.

TM 55-1520-238-T-6

ELECTRICAL SYSTEM TROUBLESHOOTING - Continued
<div align="right">

2732 00
</div>

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28 VDC - IS NOT PRESENT AT P769-A AND P769-J - Continued

8. Detach wire at CB-1. Check for short between CB2-1 and ground.

    Does short exist?
    YES   Go to step 9.
    NO   Go to step 10.

9. Remove bus bar between CB1 and CB2. Check for short between CB1 and ground.

    Does short exist?
    YES   Replace shorted MUX L PYL INBD circuit breaker (CB1) (TM 55-1520-238-23 series).
    NO   Replace shorted MUX L PYL OUTBD circuit breaker (CB2) (TM 55-1520-238-23 series).

10. Attach CB2 and CB1 wire. Detach wire at CB5-1. Check for short between (A77) J4-A and ground.

    Does short exist?
    YES   Repair shorted wire between CB1-1 and CB5-1. Go to WP 3641 00.
    NO   Go to step 11.

11. Detach wire at CB6-1. Check for short between CB5-1 and ground.

    Does short exist?
    YES   Go to step 12.
    NO   Go to step 13.

12. Remove bus bar between CB5 and CB6. Check for short between CB5 and ground.

    Does short exist?
    YES   Replace MUX R PYL INBD circuit breaker (CB5) (TM 55-1520-238-23 series).
    NO   Replace MUX R PYL OUTBD circuit breaker (CB6) (TM 55-1520-238-23 series).

13. Attach CB5 and CB6 wire. Detach wire at CB10-1. Check for short between (A77) J4-A and ground.

    Does short exist?
    YES   Go to step 14.
    NO   Repair shorted wire between CB10-1 and CB6-1. Go to WP 3641 00.

14. Remove bus bar between CB5 and CB6. Check for short between CB5 and ground.

    Does short exist?
    YES   Replace MUX FAB R circuit breaker (CB9) (TM 55-1520-238-23 series).
    NO   Replace MUX FAB L circuit breaker (CB10) (TM 55-1520-238-23 series).

<div align="center">

2732 00-3
</div>

FIGURE 7. <u>Example 2 of a narrative troubleshooting procedure.</u>

EQUIPMENT PRESETS (RF OUTPUT (dBm))

WARNING

High voltage and high RF energy is present in the power amplifier and the test setup. Use caution to avoid personal injury.
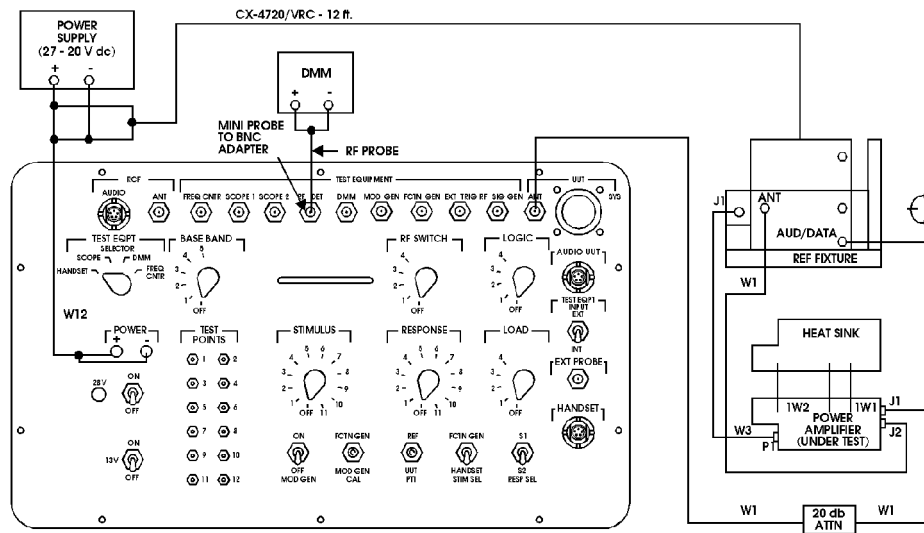
REF FIXTURE:
    CB1:   ON
    FCTN: SQ ON
    MODE: SC
    DATA: OFF
    CHAN: Do not change from operational check.

DMM:
    Set for dBm, 50 Ω REF.

POWER AMPLIFIER:
    Disassemble to gain access to test points. Do not disconnect cables.

FIGURE 8. Example of a troubleshooting test setup diagram.
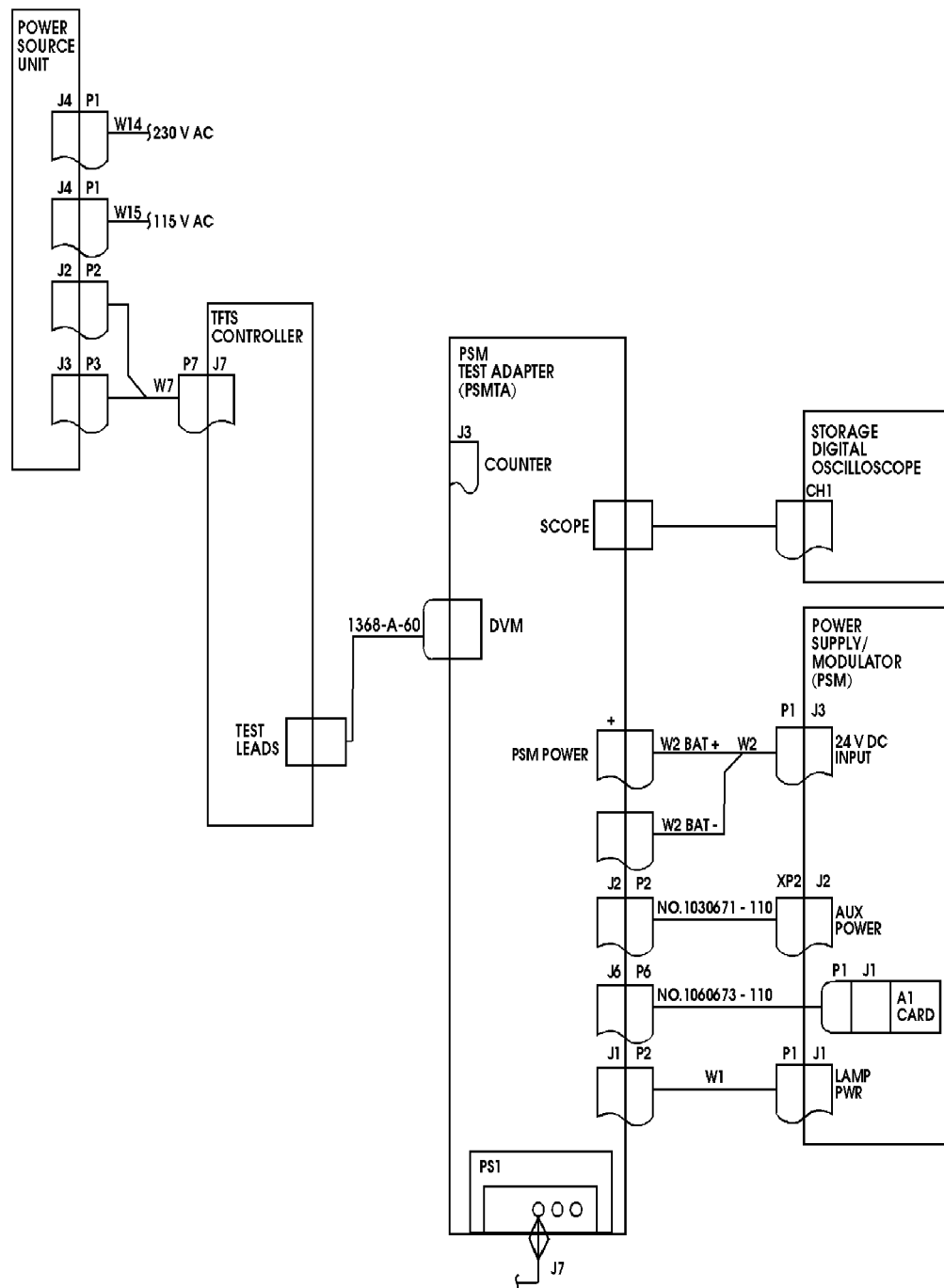
Figure 21.   Power Supply/Modulator Unit Test Cable Interconnection Diagram.

FIGURE 9. Example of a test cable interconnection diagram.

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